

WHAT IS CLAIMED IS:

1. A deinterlacing method for converting an interlaced image into a progressive image, comprising steps of:

performing a filtering process to pixels of at least one of three fields, a deinterlacing target field to be subjected to a deinterlacing process and forward and backward fields of the deinterlacing target field within the interlaced image, thereby generating an interpolation pixel for the deinterlacing target field;

measuring a quantity of motion of the deinterlacing target field; and

changing characteristics of the filtering on the basis of the quantity of the motion.

2. The deinterlacing method of Claim 1 wherein

a filter which is used for the filtering process in the step of generating the interpolation pixel has characteristics of extracting vertical low frequency components of the deinterlacing target field, and extracting vertical high frequency components of the forward and backward fields of the deinterlacing target field.

3. The deinterlacing method of Claim 1 wherein

in the step of generating the interpolation pixel, pixels in the deinterlacing target field or peripheral fields, which are

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in the same horizontal position as that of a position to be interpolated are subjected to the filtering process.

4. The deinterlacing method of Claim 1 wherein

in the step of measuring the quantity of the motion, the quantity of the motion is obtained from a difference between the deinterlacing target field or a frame including the deinterlacing target field, and other field or frame.

5. The deinterlacing method of Claim 1 wherein

in the step of measuring the quantity of the motion, the quantity of the motion is obtained from a difference between the pixels which are used when the filtering process is performed in the step of generating the interpolation pixels.

6. The deinterlacing method of Claim 5 wherein

in the step of measuring the quantity of the motion, the quantity of the motion is obtained from a difference between pixels which are included in the forward and backward fields of the deinterlacing target field, among the pixels which are used when the filtering process is performed in the step of generating the interpolation pixels.

7. The deinterlacing method of Claim 1 wherein

in the step of changing characteristics of the filtering,

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the characteristics of the filtering are changed so that gain of components from the forward and backward fields of the deinterlacing target field is reduced as the quantity of the motion is increased.

8. The deinterlacing method of Claim 1 wherein

in the step of changing characteristics of the filtering, the characteristics of the filtering are changed so that gain of components from the forward and backward fields of the deinterlacing target field is reduced to zero when the quantity of the motion is large.

9. A deinterlacing apparatus for converting an interlaced image into a progressive image, comprising:

a frame memory for storing the interlaced image;

a filter unit for receiving a deinterlacing target field to be subjected to a deinterlacing process and one or both of forward and backward fields of the deinterlacing target field within the interlaced image, from the frame memory, and performing a filtering process to pixels of at least one of the received fields, thereby generating an interpolation pixel for the deinterlacing target field;

a difference operation unit for measuring a quantity of motion of the deinterlacing target field; and

a filter coefficient setting unit for changing

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characteristics of the filter unit on the basis of the quantity of the motion measured by the difference operation unit.

- ⑩. A deinterlacing apparatus for converting an interlaced image into a progressive image comprising:
- a frame memory for storing the interlaced image;
 - a filter unit for receiving a deinterlacing target field to be subjected to a deinterlacing process and one or both of forward and backward fields of the deinterlacing target field within the interlaced image, from the frame memory, and performing a filtering process to pixels of at least one of the received fields, thereby generating an interpolation pixel for the interlacing target field;
 - a difference operation unit for receiving the deinterlacing target field or a frame including the deinterlacing target field, and a field or frame which is adjacent to the deinterlacing target field or frame including the deinterlacing target field within the interlaced image, from the frame memory, and operating a difference therebetween, thereby measuring a quantity of motion of the deinterlacing target field;
 - a filter coefficient setting unit for changing filter characteristics of the filter unit on the basis of the quantity of the motion measured by the difference operation unit; and
 - a double-speed converter for composing the interlaced image and the interpolation pixel generated by the filter unit, and

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generating the progressive image.

11. A deinterlacing method for performing a decoding process to a code sequence, field by field or frame by frame, which code sequence is obtained by coding an interlaced image composed of plural fields using motion compensation, and converting a decoded image of the interlaced image, obtained by the decoding process, into a progressive image, comprising:

a decoding step of decoding the interlaced image, thereby obtaining the decoded image as well as obtaining a motion vector at the motion compensation which indicates a prescribed reference field for a target field;

a motion vector conversion step of converting a motion vector for each of the fields, having a size corresponding to a time interval between the target field and the prescribed reference field, into a motion vector of a size corresponding to a time interval of a fixed unit;

an inter-field interpolation pixel generation step of obtaining pixels from reference fields which are forward and backward fields of a deinterlacing target field to be subjected to a deinterlacing process, on the basis of the motion vectors converted in the motion vector conversion step, and generating a first interpolation pixel for the deinterlacing target field;

an intra-field interpolation pixel generation step of generating a second interpolation pixel using pixels in the

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deinterlacing target field;

a weighting factor decision step of deciding a weighting factor which indicates a weighting ratio between the first interpolation pixel and the second interpolation pixel; and

a progressive image generation step of obtaining a weighted mean of the first interpolation pixel and the second interpolation pixel using the weighting factor, thereby generating a third interpolation pixel, and interpolating the decoded image using the third interpolation pixel, to generate the progressive image.

12. A deinterlacing method for performing a decoding process to a code sequence, field by field or frame by frame, which code sequence is obtained by coding an interlaced image composed of plural fields using motion compensation, and converting an decoded image of the interlaced image, obtained by the decoding process, into a progressive image, comprising:

a decoding step of decoding the interlaced image, thereby obtaining the decoded image as well as obtaining a motion vector at the motion compensation which indicates a prescribed reference field for a target field;

a motion vector conversion step of converting a motion vector for each of the fields having a size corresponding to a time interval between the target field and the prescribed reference field, into a motion vector of a size corresponding to a time interval of a fixed unit;

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a motion vector judgement step of judging effectiveness of the motion vectors converted in the motion vector conversion step;

an inter-field interpolation pixel generation step of obtaining pixels from reference fields which are forward and backward fields of a deinterlacing target field to be subjected to a deinterlacing process, on the basis of the motion vectors converted in the motion vector conversion step and a result of the judgement in the motion vector judgement step, and generating a first interpolation pixel for the deinterlacing target field;

an intra-field interpolation pixel generation step of generating a second interpolation pixel using pixels in the deinterlacing target field;

a weighting factor decision step of deciding a weighting factor which indicates a weighing ratio between the first interpolation pixel and the second interpolation pixel; and

a progressive image generation step of obtaining a weighted mean of the first interpolation pixel and the second interpolation pixel using the weighing factor, thereby generating a third interpolation pixel, and interpolating the decoded image using the third interpolation pixel, to generate the progressive image.

13. The deinterlacing method of Claim 11 or 12 wherein

the time interval of a fixed unit in the motion vector conversion step is a time interval equivalent to one field.

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14. The deinterlacing method of Claim 11 or 12 wherein processes in the inter-field interpolation pixel generation step, the weighing factor decision step and the progressive image generation step are carried out in units, which unit is smaller than a unit of an image accompanied by the motion vector at the motion compensation.

15. The deinterlacing method of Claim 11 or 12 wherein the code sequence is a code sequence which is coded by an MPEG method.

16. The deinterlacing method of Claim 11 or 12 wherein in the motion vector conversion step, when a distance between lines in a frame structure is one pixel, the motion vector is converted so that vertical components of the motion vector have an even number.

17. The deinterlacing method of Claim 12 wherein in the motion vector judgement step, when the size of the motion vector converted in the motion vector conversion step is equal to or smaller than a predetermined value, the motion vector is judged effective.

18. The deinterlacing method of Claim 12 wherein in the motion vector judgement step, when a distance between

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lines in a frame structure is one pixel, a motion vector which has even-numbered vertical components among the motion vectors converted in the motion vector conversion step is judged effective.

19. The deinterlacing method of Claim 11 wherein

in the inter-field interpolation pixel generation step, an evaluation scale for selecting an optimum motion vector for the generation of the first interpolation pixel is calculated using the motion vectors converted in the motion vector conversion step, and the first interpolation pixel is generated using a motion vector with which the best evaluation scale is obtained.

20. The deinterlacing method of Claim 11 wherein

in the inter-field interpolation pixel generation step, an evaluation scale for selecting an optimum motion vector for the generation of the first interpolation pixel is calculated using the motion vector converted in the motion vector conversion step and a motion vector in the opposite direction to the motion vector, and the first interpolation pixel is generated using a motion vector with which the best evaluation scale is obtained, and

the motion vector in the opposite direction is a motion vector which is in the opposite direction to the motion vector converted in the motion vector conversion step and indicates a reference field in an opposite forward/backward relationship to

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the reference field indicated by the motion vector with respect to the target field.

21. The deinterlacing method of Claim 12 wherein

in the inter-field interpolation pixel generation step, an evaluation scale for selecting an optimum motion vector for the generation of the first interpolation pixel is calculated using a motion vector which is judged effective in the motion vector judgement step, among the motion vectors converted in the motion vector conversion step, and the first interpolation pixel is generated using a motion vector with which the best evaluation scale is obtained.

22. The deinterlacing method of Claim 12 wherein

in the inter-field interpolation pixel generation step, an evaluation scale for selecting an optimum motion vector for the generation of the first interpolation pixel is calculated using an effective motion vector which is judged effective in the motion vector judgement step and a motion vector in the opposite direction to the effective motion vector, among the motion vectors converted in the motion vector conversion step, and the first interpolation pixel is generated using a motion vector with which the best evaluation scale is obtained, and

the motion vector in the opposite direction is a motion vector which is in the opposite direction to the effective motion

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vector and indicates a reference field in an opposite forward/backward relationship to the reference field indicated by the effective motion vector with respect to the target field.

23. The deinterlacing method of any of Claims 19 to 22 wherein in the inter-field interpolation pixel generation step, an evaluation scale for selecting an optimum motion vector for the generation of the first interpolation pixel is calculated using the motion vector converted in the motion vector conversion step and a motion vector having no motion, and the first interpolation pixel is generated using a motion vector with which the best evaluation scale is obtained.

24. The deinterlacing method of any of Claims 19 to 22 wherein the evaluation scale is a sum of absolute values of differences between pixels of the reference field which is indicated by the motion vector converted in the motion vector conversion step and the second interpolation pixels.

25. The deinterlacing method of Claim 23 wherein the evaluation scale is a sum of absolute values of differences between pixels of the reference field which is indicated by the motion vector converted in the motion vector conversion step and the second interpolation pixels.

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26. The deinterlacing method of any of Claims 20 to 22 wherein the evaluation scale is a sum of absolute values of differences between pixels of the reference field which is indicated by the motion vector converted in the motion vector conversion step and pixels of a reference field which is indicated by the motion vector in the opposite direction.

27. The deinterlacing method of any of Claims 20 to 22 wherein in the inter-field interpolation pixel generation step, an evaluation scale for selection an optimum motion vector for the generation of the first interpolation pixel is calculated using the motion vector converted in the motion vector conversion step and a motion vector having no motion, and the first interpolation pixel is generated using a motion vector with which the best evaluation scale is obtained, and

the evaluation scale is a sum of absolute values of differences between pixels of the reference field which is indicated by the motion vector converted in the motion vector conversion step and pixels of the reference field which is indicated by the motion vector of the opposite direction.

28. A deinterlacing method for generating an interpolation pixel for an interlaced image which is composed of plural fields, using pixels in each of the fields, and converting the interlaced image into a progressive image, comprising:

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an edge detection step of detecting a direction indicated by a line passing through a position to be interpolated where the interpolation pixel is generated and connecting peripheral pixels of the position to be interpolated, as a direction of an edge;

an edge reliability decision step of obtaining a strongness of a correlation between pixels existing in the direction of the edge, as a reliability of the edge; and

an interpolation pixel generation step of generating the interpolation pixel using the pixels existing in the direction of the edge when the reliability of the edge is equal to or larger than a predetermined value, and generating the interpolation pixel using pixels existing in upper and lower directions of the position to be interpolated when the reliability of the edge is smaller than the predetermined value.

29. The deinterlacing method of Claim 11 or 12 wherein the intra-field interpolation pixel generation step including:

an edge detection step of detecting a direction indicated by a line passing through a position to be interpolated where the second interpolation pixel is generated and connecting peripheral pixels of the position to be interpolated, as a direction of an edge;

an edge reliability decision step of obtaining a strongness of a correlation between pixels existing in the direction of the

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edge, as a reliability of the edge; and

an interpolation pixel generation step of generating the second interpolation pixel using the pixels existing in the direction of the edge when the reliability of the edge is equal to or larger than a predetermined value, and generating the second interpolation pixel using pixels existing in upper and lower directions of the position to be interpolated when the reliability of the edge is smaller than the predetermined value.

30. The deinterlacing method of Claim 28 wherein

in the edge reliability decision step, when a difference between the pixels existing in the direction of the edge is smaller than a difference between the pixels existing in the upper and lower directions of the position to be interpolated, the reliability of the edge is judged to be equal to or larger than the predetermined value.

31. The deinterlacing method of Claim 29 wherein

in the edge reliability decision step, when a difference between the pixels existing in the direction of the edge is smaller than a difference between the pixels existing in the upper and lower directions of the position to be interpolated, the reliability of the edge is judged to be equal to or larger than the predetermined value.

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32. The deinterlacing method of Claim 28 wherein
in the edge reliability decision step, when the
interpolation pixel value which is obtained using the pixels
existing in the direction of the edge is a value between values
of the pixels existing in the upper and lower directions of the
position to be interpolated, the reliability of the edge is judged
to be equal to or larger than the predetermined value.

33. The deinterlacing method of Claim 29 wherein
in the edge reliability decision step, when the
interpolation pixel value which is obtained using the pixels in
the direction of the edge is a value between values of the pixels
existing in the upper and lower directions of the position to be
interpolated, the reliability of the edge is judged to be equal
to or larger than the predetermined value.

34. The deinterlacing method of Claim 11 or 12 wherein
for an intra-coded deinterlacing target image area in the
deinterlacing target field, the deinterlacing process is
performed using a motion vector which accompanies a peripheral
image area positioned around the deinterlacing target image area
or an image area in a frame immediately preceding or immediately
following the deinterlacing target field, which image area is at
the same position as that of the deinterlacing target image area.

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35. The deinterlacing method of Claim 11 or 12 wherein
when the code sequence which is decoded in the decoding step
is recorded on a recording medium and read in a fast-forward or
fast-rewind mode, the decoded image is interpolated using only
the second interpolation pixel generated in the intra-field
interpolation pixel generation step, thereby generating the
progressive image.

36. A deinterlacing apparatus for performing a decoding process
to a code sequence obtained by coding an interlaced image which
is composed of plural fields using motion compensation, field by
field or frame by frame, and converting a decoded image of the
interlaced image, obtained by the decoding process, into a
progressive image, comprising:

a decoder for decoding the interlaced image, thereby
obtaining the decoded image as well as obtaining a motion vector
at the motion compensation which indicates a prescribed reference
field for a target field;

an image memory for storing the decoded image;

a parameter memory for storing the motion vector;

a motion vector converter for converting a motion vector
for each of the fields, having a size corresponding to a time
interval between the target field and the prescribed reference
field, which is read from the parameter memory, into a motion vector
of a size corresponding to a time interval of a fixed unit;

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an inter-field interpolation pixel generator for obtaining pixels from reference fields which are forward and backward fields of a deinterlacing target field to be subjected to a deinterlacing process, on the basis of the motion vectors converted by the motion vector converter, and generating a first interpolation pixel for the deinterlacing target field;

an intra-field interpolation pixel generator for generating a second interpolation pixel using pixels in the deinterlacing target field;

a weighing factor decision unit for deciding a weighing factor which indicates a weighing ratio between the first interpolation pixel and the second interpolation pixel; and

a progressive image generator for obtaining a weighted mean of the first interpolation pixel and the second interpolation pixel using the weighing factor, thereby generating a third interpolation pixel, and interpolating the decoded image read from the image memory using the third interpolation pixel, to generate the progressive image.

37. A deinterlacing apparatus for performing a decoding process to a code sequence obtained by coding an interlaced image which is composed of plural fields using motion compensation, field by field or frame by frame, and converting a decoded image of the interlaced image, obtained by the decoding process, into a progressive image, comprising:

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a decoder for decoding the interlaced image, thereby obtaining the decoded image as well as obtaining a motion vector at the motion compensation which indicates a prescribed reference field for a target field;

an image memory for storing the decoded image;

a parameter memory for storing the motion vector;

a motion vector converter for converting a motion vector for each of the fields, having a size corresponding to a time interval between the target field and the prescribed reference field, which is read from the parameter memory, into a motion vector of a size corresponding to a time interval of a fixed unit;

a motion vector judgement unit for judging effectiveness of the motion vectors converted by the motion vector converter;

an inter-field interpolation pixel generator for obtaining pixels from reference fields which are forward and backward fields of a deinterlacing target field to be subjected to a deinterlacing process, on the basis of the motion vectors converted by the motion vector converter and a result of the judgement by the motion vector judgement unit, and generating a first interpolation pixel for the deinterlacing target field;

an intra-field interpolation pixel generator for reading pixels in the deinterlacing target field to generate a second interpolation pixel;

a weighting factor decision unit for deciding a weighting factor which indicates a weighting ratio between the first

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interpolation pixel and the second interpolation pixel; and

a progressive image generator for obtaining a weighted mean of the first interpolation pixel and the second interpolation pixel using the weighting factor, thereby generating a third interpolation pixel, and interpolating the decoded image read from the image memory using the third interpolation pixel, to generate the progressive image.

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